

Strategic Energy Research

SUBSTATION RELIABILITY PROJECT

Gray Davis, Governor

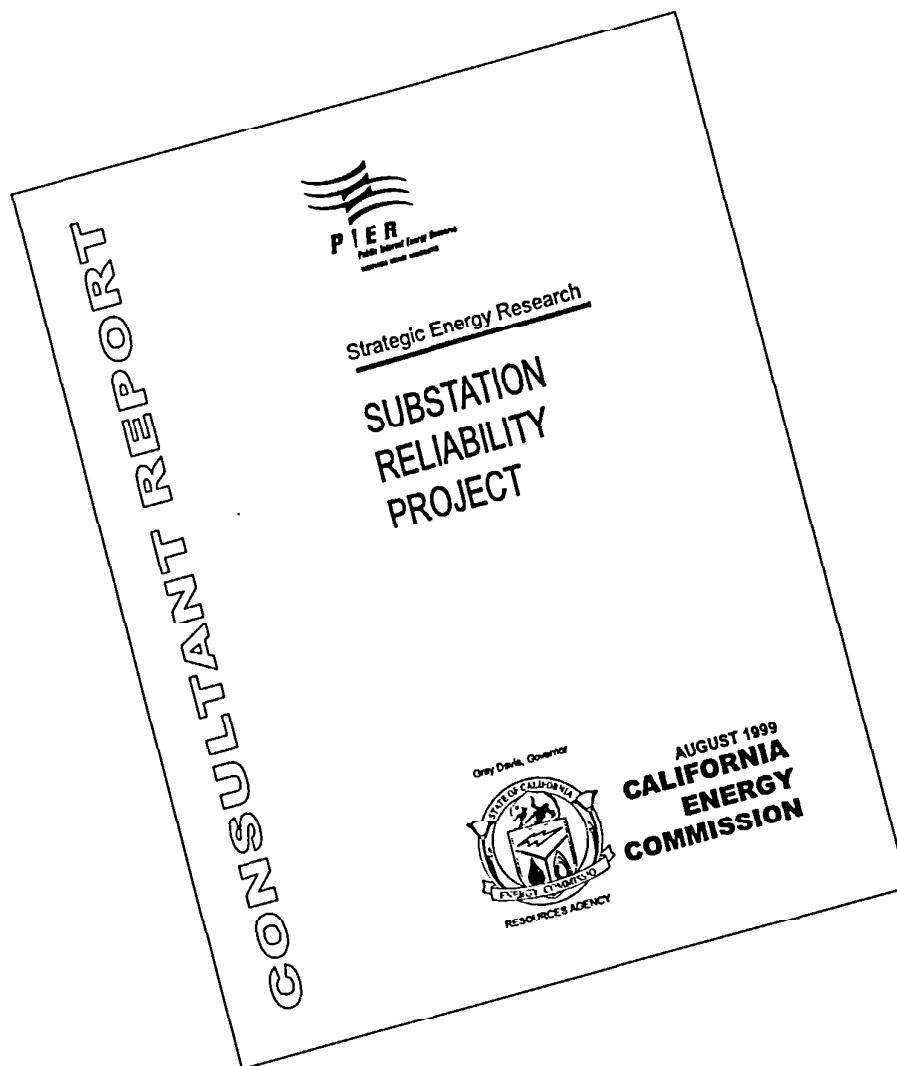


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Preface

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program, managed by the California Energy Commission (Commission), annually awards up to \$62 million through the Year 2001 to conduct the most promising public interest energy research by partnering with Research, Development, and Demonstration (RD&D) organizations, including individuals, businesses, utilities, and public or private research institutions.

PIER funding efforts are focused on the following six RD&D program areas:

- Buildings End-Use Energy Efficiency
- Industrial/ Agricultural/Water End-Use Energy Efficiency
- Renewable Energy
- Environmentally-Preferred Advanced Generation
- Energy-Related Environmental Research
- Strategic Energy Research.

In 1998, the Commission awarded approximately \$17 million to 39 separate transition RD&D projects covering the five PIER subject areas. These projects were selected to preserve the benefits of the most promising ongoing public interest RD&D efforts conducted by investor-owned utilities prior to the onset of electricity restructuring.

What follows is the final report for the Substation Reliability project, one of five projects conducted by Southern California Edison. This project contributes to the Strategic Energy Research program.

For more information on the PIER Program, please visit the Commission's Web site at: <http://www.energy.ca.gov/research/index.html> or contact the Commission's Publications Unit at 916-654-5200.

Executive Summary

In a deregulated environment, increased substation monitoring and control automation to maximize usage of transmission and distribution assets is critical. Automated monitoring and control has a dual purpose:

- Allows operation of power networks at the highest reliability levels economically possible.
- Keeps pace with the tremendous volume of free-market energy transactions.

But the increased amount of data generated by the new monitoring and automation systems has a limited value if it is not correctly processed into usable information. Today in most cases, large amounts of raw data can easily inundate control room operators, hindering rather than helping reliable system operation.

Objectives

The objectives were to

- Demonstrate, under realistic conditions, the feasibility and potential benefits of intelligent alarm analysis and voice recognition technologies as means of alleviating the data processing problem.
- Evaluate voice recognition tools as a means of improving system reliability by freeing the operators' eyes and hands, improving their response time and effectiveness in taking remedial action.

Approach

A subcontractor, Hathaway Industrial Automation (HIA) developed the initial stage of the Alarm Analyzer tool. The Alarm Analyzer tool is an intelligent alarm analysis and diagnostics system that automatically classifies and filters thousands of pieces of information and alarms generated during an abnormal event on the grid.

For reasons of practicality and reliability, the demonstrations were performed off-line to avoid causing any disruption to the operating power system.

Equipment

The main hardware selected for the Alarm Analyzer system was the Hathaway DAS 4000 substation information server (SIS) and a Sun Workstation. The SIS contains the necessary protocols to interface with the relays and other monitoring devices with minimum customization. It has enough computational capacity in its calculator to process the analyzer's logic program.

Voice Recognition

The Voice Recognition demonstrations were performed at four different Southern California Edison (SCE) sites and involved three different applications. The sites were two substations (Lighthipe and Moorpark), the Compton Metropolitan Transmission Office, and the Rosemead facility. The three applications were the substation, the transmission field crew, and the office.

Lighthipe: Management requested development of four reporting forms to enable input of text directly by voice and the operators requested an electronic version of their scratch pads. Voice Connexion created a Visual Basic program using the Multiple Document Interface (MDI) feature. This program, known as Multi-Notes, is intended to replace the operators' pencils and paper scratch pads with voice-entered notes and to transfer selected notes into TaskMaster 4.0. MultiNotes.

Moorpark: SCE demonstrated the same four reports as were demonstrated at Lighthipe, but experienced software compatibility problems. For the majority of work in substation applications, direct voice entry into TaskMaster 4.0 was preferred to Multi-Notes. Except during peak workloads, Multi-Notes did not provide significant timesavings,

Compton Metropolitan Transition Office: The demonstration involved a field transmission line patrolman who inspects overhead lines and structures as he drives by. To fill out the required one-page form with comments, the patrolman has to either stop the vehicle or wait until he is back at his desk.

Voice input allowed all information to be entered on the form approximately three times faster than by hand. Accuracy was almost 100 percent. This application demonstrated that voice recognition technologies freed the inspector's hands and eyes and enabled multitasking. However, the patrolman and his supervisor expressed the opinion that the comments in the report are usually too short to warrant changing to voice input only.

Rosemead: This involved demonstrating an office application for a manager who was confined to a wheelchair with limited hand and arm mobility. The individual reported that the Via Voice system was accurate and easy to use. He said his productivity improved when using voice input for long documents. The primary drawback was that in a cubicle environment, there was too much distraction for effective voice input. The lack of privacy led to a feeling of self-consciousness.

Outcome

- The Alarm Analyzer accurately detected, located, and identified disturbances in both scenarios.
 - Reduced the time required to produce an accurate diagnostic of an event from several hours or days to less than 2 minutes.
 - Alarms generated were filtered and reduced in number from seven to one in all scenarios.
- The voice recognition tools increased productivity by at least 200 percent in entering information into a computer file.
 - Four reports could be completed by voice input in less than half the time needed by a touch typist using a keyboard and mouse.
 - A 97 percent accuracy was achieved. This improved with increased use of the program.

Benefits to California

- Improved power delivery system reliability resulting in increased safety and economic savings.
- Increased access to available low-cost energy resources.
- Environmental benefits include a decrease need to build generation and transmission lines.

Conclusions

- Voice data input has strong potential to improve productivity and accuracy. For control room operators and the patrolman, this could contribute to improved reliability at substations and lines.
- While the technology is ready for system-wide use, applications have to be judiciously selected, and implemented with care to avoid interface problems.

Recommendations

- A pilot project at a typical regional control center of the intelligent alarm analyzer is strongly recommended.
- The intelligent alarm analyzer's information on the type and location of the disturbance should be combined with an outage estimator system to generate an alert and inform the affected customers of the expected outage duration time.

Abstract

In a deregulated environment, increased substation monitoring and control automation is necessary to keep up with the tremendous volume of free-market energy transactions and to operate the power networks at the highest reliability levels economically possible. However, the increased amount of data generated by the new monitoring and automation systems overwhelms control room operators. To alleviate this problem, Southern California Edison (SCE) demonstrated the feasibility of an Alarm Analyzer tool and a voice recognition system. The Alarm Analyzer tool is an intelligent alarm analysis and diagnostics system that automatically classifies and filters the thousands of pieces of information and alarms generated during an abnormal event on the grid, such as a regional blackout caused by a fault. The project also implemented and evaluated a voice recognition technology for the entry of data and commands into computers or other devices in control rooms and other installations. Field demonstrations indicated that the intelligent alarm analyzer and voice recognition technologies have the potential to improve the quality of the decisions and streamline execution of the procedures followed by utility personnel in the field, the control room, and the office. The following conclusions were reached: Use of the Alarm Analyzer could reduce the time required to produce an accurate diagnostic of an event from several hours or days to less than two minutes. Voice recognition tools of the type evaluated in this project could realistically result in a productivity increase as high as 200 percent in entering information to a computer file with an error rate lower than three percent.

1.0 Introduction

1.1 Statement of the Problem

Electrical power delivery systems are an essential ingredient in the development of any modern society. Dependence on electricity is driven by the extensive and widespread use of equipment, appliances, and instrumentation that operate on electricity. Because of this growing dependence, when electric power flow is interrupted, the consequences can be catastrophic – not unlike the effects of cutting off the blood supply in a living being. It is therefore not surprising that traditionally an extraordinary amount of care has been exercised in the design, construction, and operation of electric power grids. Clearly, the largest systems with the highest reliability man has ever created are the electric power systems.

Key to achieving improved reliability rates for the complete power system, typically as high as 99.999 percent, is the reliable operation of substations and their corresponding equipment. It is at the substations that power is conditioned and directed under both normal and abnormal conditions. Substations function as control nodes in a grid where voltage transformations and current switching are performed.

Substations, in conjunction with electric generation plants, control the energy flows. As an example, a substation may have two bulk power or source lines and 5 to 15 distribution feeder circuits. This typical arrangement clearly indicates that it is much more effective and economical to implement reliability improvements at the substation level than in the individual circuits. The impact on both frequency and duration of service interruptions and on the number of users affected by these outages depends more on the manner in which substation components perform than on the performance of circuit components downstream.

Reliability degradation in the last decade has several causes. Clearly, United States power systems have reached the end of their service life. Many of the grids were built in the late 1940s and early 1950s to literally power the post-war economic boom. Additions and relatively small upgrades have accommodated the moderate-and low-load growth seen from about 1970 through the present. But the basic infrastructure has reached and passed middle age, and breakdowns have naturally increased. With the uncertainty and risk regarding ownership of the generation and grid assets, utilities have been hesitant to improve existing facilities or build new ones.

Direct access due to deregulation, and before that, the interconnection of third-party generation sources to the grid, have imposed electrical stresses on the system beyond its original design limits. For example, new plants were sited where it was convenient for the new owners in terms of initial investment and operating costs. Minimum regard was given to the effect of these plants on the reliability of the total power system, and no consideration was given to using these new plants to support the system during contingencies.

Furthermore, the operators in the new installations are less experienced than those in existing utilities. With the growing number of third-party generators and the spread of distributed generation, this condition will continue. Lastly, the motives and modes of operating the system have drastically changed from the traditional goal of safe and reliable service to that of profit above all else. The excessive number of regional-type blackouts and brownouts endured

throughout the Nation during the last two summers testifies to the general decline in power system reliability.

The alternative solution of building additional generation and transmission lines is environmentally and economically unacceptable. Even if the costs were reasonable and the large amounts of needed capital available, society would not allow the destruction of the environment that would accompany new construction on a national scale. Direct replacement would be an alternative with much less environmental impact. Although it would be more expedient, the cost would still be high, since a simple direct replacement would result in only a small gain in capacity.

In the past, remedial actions performed in a coordinated manner by operators from various neighboring utilities worked well to avoid or at least limit regional outages. This was possible because the systems' design margins were respected and utilities were willing to collaborate on the solution of these and other mutual issues.

Today the approach adopted by many utilities is that of maximizing the usage of existing assets. The assumption is that safe and reliable operation closer to the margin can be achieved by increasing the amount of monitoring to better control the system. It is also assumed that the benefits derived from the increase in capacity obtained will outweigh the initial and ongoing costs of these monitoring systems.

1.2 Project Objectives

To maximize usage of transmission and distribution assets in a deregulated environment, more substation monitoring and control automation is now necessary. Automated monitoring and control has a dual purpose:

- Operate the power networks at the highest reliability levels economically possible.
- Keep pace with the tremendous volume of free-market energy transactions.

However, the increased amount of data generated by the new monitoring and automation systems has limited value if it is not processed correctly into usable knowledge. Today, in most cases, large amounts of raw data can easily inundate control room operators, which hinders rather than aids the reliable operation of the system.

This project demonstrated, under realistic conditions, the feasibility and potential benefits of intelligent alarm analysis and voice recognition technologies as means of alleviating this problem.

The project objectives were to:

- Complete the initial stage of development of an intelligent alarm analysis and diagnostics system to automatically classify and filter the thousands of pieces of information and alarms generated during an abnormal event on the grid, such as a regional blackout caused by a fault. The scope was limited to investigating the feasibility of the Alarm Analyzer tool.

- Implement voice recognition technology and evaluate its benefits in the entry of data and commands into a computer or other device in control rooms and other applications. Determine user acceptance of current voice recognition technology and estimate timesavings using voice recognition for selected work tasks.

1.3 Purpose and Organization of This Report

This report documents the evaluation of the feasibility and benefits of alarm analysis technologies and makes the information available to those undertaking similar studies in the future.

The report is organized into the following sections: Introduction; Technical Approach; and Conclusions and Recommendations. The Technical Approach section covers the concept development, installation and testing, and demonstrations of the Alarm Analyzer tool and voice recognition technologies.

1.4 Technical Concepts of the Proposed Solutions

The concepts behind the proposed technologies are straightforward, but their implementation is highly complex. It has required many years of development by the most advanced research centers in the respective fields. Fortunately, the timing of this project, in terms of the development status of the technologies, and the integration of the appropriate components and the applications, was excellent.

The cost of the required hardware and software has dramatically decreased, to the point where their commercial use has become attractive. The issues remaining dealt mostly with the costs and consequences of their adaptation to particular applications. For example, the effort of interfacing the new hardware and software with existing hardware and software, the ease of use, and the value derived from their application had to be determined.

The concept of the Alarm Analyzer is centered on having a knowledge base (reference) of the normal and abnormal states of the system, receiving real-time information on the sequence of events occurring for various contingencies, and comparing the new information against the reference. For control room operators, this means filtering nuisance, sympathetic, and irrelevant alarms, processing the relevant information; prioritizing it; displaying the root cause of the event (type of fault), where it is located (component involved), and recommended action (future version of Alarm Analyzer).

Communications and computational technologies have matured sufficiently to perform all steps in less than a minute for large control areas involving several hundred buses. They are also now affordable. Given the necessary field inputs, the desired analyzer functions at this stage can be performed by rule- and simple-logic-based decision programs.

Voice recognition, on the other hand, requires highly complex algorithms to allow rapid and highly accurate interpretation and conversion of speech spoken by any speaker. Sophisticated pattern recognition techniques are employed. Within the last four years, great breakthroughs have been achieved and today's commercially available software can recognize more than 120,000 words in context, dictation is continuous, and training and enrollment takes less than

three hours. The programs cost less than \$200 and can be run successfully on the lowest end Pentiums, opening up many applications for voice recognition.

1.5 Commercialization Potential

The limited economic information obtained while performing this feasibility project and previous experience working in the utility industry have led to the following observations regarding the Alarm Analyzer and Voice Recognition technologies:

- The Alarm Analyzer promises to be a tool urgently needed not only by control room operators in the utilities, but by the new generation and transmission system operators, such as California Independent System Operators (CALISO), and large customer-owned power facilities (such as refineries).
- The concept of the Alarm Analyzer can be scaled down and applied in industrial plants and processes.
- The need for Alarm Analyzers in the electric power industry will continue to grow as utilities merge and become more interconnected and power exchange transactions increase in number, with direct access down to the residential customer-level nationwide.
- The expected cost of an Alarm Analyzer will vary widely depending on the complexity of the power grid on which it is being applied. To reduce the cost, the commercial version of the Alarm Analyzer must be designed for simple initial programming and for automatic self-reprogramming to accommodate changes.
- In the case of voice recognition technology, applications that involve large blocks of text result in the highest productivity gains. However, jobs where the operator has to both use their hands and eyes while making notes or entering data are ideal candidates for voice tools. Although the time to complete the job may be reduced only slightly, the quality and accuracy of the job can improve significantly, because multitasking is significantly enhanced with voice data entry and voice computer navigation.
- To create a market for voice recognition products, it is necessary to educate potential customers and thus gain wider acceptance for the technology.

1.6 Benefits to California

The benefits expected for the State of California from the application of the technologies proposed in this project can be categorized as follows:

- Higher power delivery system reliability translates directly into a better quality of life. This becomes most noticeable in the event of a power outage, when loss of life and economic losses are highly probable.
- Improved reliability also produces economic savings. Power disruptions can result in millions of dollars in losses when large areas and several hours are involved. The Alarm Analyzer can directly alleviate this problem. Since voice recognition has been shown to improve work productivity, it also yields potential economic benefits.
- For any electric utility user to enjoy the benefits of direct access, all must have the capability to access any available low-cost energy resource at any time. For this to

happen, it is necessary to have a stable and robust system. The Alarm Analyzer and voice recognition technologies both contribute to this end.

- Environmental benefits are derived from improved reliability and from the capability to access distant and diverse energy sources. On a reliable system, less generation and transmission lines need to be built, and if they must be built, they can be located where there is minimal impact on the environment.

2.0 Technical Approach

2.1 Alarm Analyzer Task

2.1.1 Concept Development and Prototype Design

The project used status and measurement information and time-tagged event information, obtained from Asea Brown Boveri (ABB) relays, to determine the existence of conditions that should be alarmed to the operator, as well as conditions of predictable alarms that should be filtered prior to presentation to the operator. This is the initial phase of a more sophisticated smart alarming project.

The goal and scope of this first phase was limited to the implementation of logic within the substation to identify a small, selected set of conditions that should be treated and alarmed (or ignored) differently than is done with conventional supervisory control and data acquisition (SCADA) technology. Appendix I, *Preliminary Requirements Summary*, provides further details on the prototype specification and work plan.

Initially, Test Laboratories Inc. (TLI) supplied the equipment needed to implement a prototype. However, their proposed design concepts were not compatible with SCE's present or future installations. This was verified on a field inspection to Houston Lighting and Power where TLI had conducted a similar project. As a result, SCE selected an alternate supplier, Hathaway Industrial Automation (HIA).

HIA provided a Substation Information Server (SIS) unit and a configuration and Human Machine Interface (HMI) workstation, both installed to simulate the Dalton substation. In addition to providing the hardware, HIA implemented local logic to perform the fault/event detection logic based on data obtained from ABB relays. The SIS unit was attached to the substation Ethernet LAN and used Modbus+ communications to receive data from the ABB relays. The data had to be sufficient, in both type and nature, to permit the logical computations required to detect the specific set of conditions selected for the first phase of testing.

SCE and HIA defined the test scenarios and the data required for implementation. Implementation included the creation of simulation screens to permit the manipulation of the test scenario data so that the logic in the SIS could be tested without requiring that the ABB relays to detect an actual fault.

HIA provided training to SCE personnel in the use of the configuration and application development tools of the SIS and the workstation. The workstation was supplied with a full set of such tools and HMI applications including a custom graphic display builder, a trending package, an alarming package, a report generator, and a historian.

At the conceptualization stage SCE and HMI made the following key assumptions, which the prototype tests validated:

- It is possible to obtain the data from the ABB relays necessary for making the logical decisions within the SIS in a timely manner.
- The scenarios selected can be accurately and thoroughly defined and detailed

- Testing of the logic can be done through some means of creating the specified scenarios using the ABB relays.

2.1.2 Installation and Testing

2.1.2.1 Introduction

The purpose of the tests was to verify that the Alarm Analyzer supplied by HIA met SCE's requirements for smart substation alarming. Testing also presented an opportunity to train SCE personnel through active participation in the project. The terms listed below are used to describe system components and the testing and simulation equipment used in the test:

- **Workstation.** This term indicates the UNIX equipment used for the HMI, for configuration of the system, and as an X-server.
- **SIS.** This term indicates the Pentium computer that provided communications to the relays and RTUs.

Except where noted, tests were designed to run in the sequence given here. The proper sequencing of tests was necessary because of setup procedures that may have been necessary in previous tests. However, circumstances often required that the sequence be interrupted. Such interruption or rescheduling required the agreement of SCE and HIA so that the impact of the sequence interruption would be recognized.

Successful testing usually involves the active participation and understanding of test procedures by both parties, but to expedite matters, it was primarily HIA personnel who executed the tests. This provided SCE with the opportunity to observe and question the test results. Upon successful completion of each section, the test supervisors signed off that section as complete and accepted.

The test period began with an orientation meeting for all personnel involved in the testing. The purpose was to review the test procedures and to establish what was to be accomplished by the end of the test period. The test period concluded with a review meeting. If unsatisfactory test results were obtained, this meeting would determine the proper course of action needed to obtain satisfactory results. Each day of the test period began with a brief meeting to establish the day's test plan and closed with a brief meeting to review and prioritize any pending discrepancy reports.

The first step in the testing procedure was to inspect the hardware shipment for completeness and quality. The system test configuration was verified by a walk-through inspection. During this walk-through, all test personnel became familiar with the overall configuration. Table 1 shows the additional test equipment used for the simulation.

Table 1. Additional Test Equipment

Description	Supplier
PLC and PLC program to simulate relay global data	HIA and others
TPU 2000R and DPU 2000R Relays	SCE

2.1.2.2 Start-Up and Initialization Procedure

System start-up and initialization was an automatic process requiring no user intervention beyond applying power to the individual components. The Sun system was configured to start the necessary DAS4000 programs. SIS was configured to automatically load from the Sun workstation. This portion of the test covered the proper startup and shutdown procedures for the DAS4000 system.

1. Start with the Sun workstation and its peripherals turned off.
2. Use the power switch to apply power to all of the workstation's external devices.
3. Use the power switch to apply power to the CRT display monitors.
4. Use the power switch to apply power to the Sun workstation processor. After a brief interval, the Sun workstation processor will automatically run its power-up diagnostics, its start-up script, and finally prompt for login.
5. Logon to the system using "TIS4000" for user name and password. The window environment will start up with the applicable windows for the station being started.

2.1.2.3 Restart Procedure

This procedure was also demonstrated.

1. Apply power to the SIS. The communication link is initiated automatically.
2. Verify that the system is up and functioning correctly.
3. Prior to powering down the Sun computer, disable the DAS4000 software. To do so, log on as root with the password tissystem, change to the TIS4000/tasks directory (cd/export/home/tis4000/tasks), and stop the DAS4000 software (stop_TIS). Type "init 5" to halt the Sun's operating system and shut down the Sun computer. The CRT display monitor should be turned off first and external devices last.
4. Turn off the SIS.
5. Repeat the power-up and initialization sequence described above, and restore the system to full operation on the network.
6. Log on to the system and verify that all communication functionality has resumed.

At the completion of this test, it was expected that all system equipment be powered up and connected.

2.1.2.4 Acceptance

Following the procedures described above, the system had to be taken to a fully inoperable and powered-down state and then restored to full functioning. The test was considered acceptable if system function was fully restored after completion of the procedures. If additional steps were required, the test document had to be amended to include and properly document these additional steps.

2.1.2.5 Smart Alarming

This section of the test procedure verified the ability of the DAS400 to properly filter alarms based on the scenarios provided by SCE for this project. The intent of this demonstration was to show the feasibility of automatic alarm analysis for substation control rooms. The objective was to filter irrelevant and sympathetic alarms, and present to the operator a very brief message stating what event took place, where, and a list of only those alarms that were relevant to his purposes.

- **Scenario 1 – Extended Delay.** If the following signals change from normal to alarm, wait 5 seconds to alarm: Relay AC Potential Fail, RH Liquid HLI, RH Liquid PW Fail, RH L. Ellen HLI, RH L. Ellen PW Fail, Azusa Citrus HLI, and Azusa Citrus PW Fail.

Procedure:

1. Display the graphic for Scenario 1 on the CRT. Ensure that the system is updating the display.
 2. Using the PLC program to simulate values from the relays, change the state on the first signal. Signal should stay in the alarm state for five seconds before the alarm is heard.
 3. Using the PLC program, change the state of the point back to normal and clear the alarm.
 4. Using the PLC program to simulate values from the relays change the state of the first signal again, but this time change it back to normal before 5 seconds have elapsed. Verify that the value changed on the display but no alarm was sounded or recorded in the alarm log.
 5. Repeat steps 2 through 4 for all the remaining test points.
- **Scenario 2 – 12 kV Bus Tie CB Trip.** If the 12 kV Bus Tie goes from closed to open, inhibit the following alarms: Relay AC Potential Fail, RH Liquid HLI, RH Liquid PW Fail, RH L. Ellen HLI, RH L. Ellen PW Fail, Azusa Citrus HLI, and Azusa Citrus PW Fail.

Procedure:

1. Display the graphic for Scenario 2 on the CRT. Ensure that the system is updating the display.
 2. Using the PLC program to simulate a 12 kV Bus Tie changing from closed to open and all of the signals above go from normal to alarm.
 3. Verify that the alarm for the 12 kV Bus Tie is displayed, the alarm is sounded, and that none of the other signals were alarmed.
- **Scenario 3 – 12 kV Line CB Trip.** If any of the 12 kV Line CBs (Bender, Jarvis, Damerel, Gravel, Von, Lager, Concrete, Winark) go from closed to open, inhibit the following alarms: Relay AC Potential Fail, RH Liquid HLI, RH Liquid PW Fail, RH L. Ellen HLI, RH L. Ellen PW Fail, Azusa Citrus HLI, and Azusa Citrus PW Fail.

Procedure:

1. Display the graphic for Scenario 3 on the CRT. Ensure that the system is updating the display.

2. Using the PLC program to simulate one of the 12 kV Line CBs changing from closed to open and all of the signals above go from normal to alarm.
3. Verify that the alarm for the selected 12 kV Line CB is displayed and is sounded, and that none of the other signals were alarmed.
4. Clear the alarms.
5. Repeat steps 2 through 4 for all of the remaining Line CBs and in any combination desired.

2.1.2.6 System Utilities

The purpose of this test was to demonstrate the system utilities that are included with the system, such as database creation, display creation, and alarm configuration. The testing also included demonstration of the on-line configuration tools.

The standard DAS/4000 utilities demonstrated in this test included:

- DataVu
- AlarmVu
- DisplayVu (edd/dm).

Procedure. From the workstation, run the listed utilities and demonstrate the features and functions of each. Create actual database blocks, download them to the SIS, and create displays to view them and add them to the alarm manager and displays.

2.1.2.7 Y2K Readiness Check

The test demonstrated the system's capability to properly handle the date transition from 1999 to 2000 without manual intervention, and to show that, as a whole, the system would not be adversely affected by the migration of the year representation from the 1900s into the 2000s. The test showed that the system continued to function normally, and that no data was lost or miscalculated, prior to, during, and after the transition from 12/31/1999 to 1/1/2000.

- **Procedure.** Set the system clock in the workstation set to December 31, 1999 at 23:30 hours. Allow the system to run and simulate points changing status. At 00:30 hours on January 1, 2000, collected data will be displayed along with the recorded alarms to show the system remained functioning. Retrieve information from the system and review it to verify its correctness.
- **Acceptance.** The system's functions will not be impacted by the year rollover and no data will be lost or incorrectly computed due to the rollover. If no collected information is lost, misfiled, or miscalculated, and the system continues to function properly, the test will be considered successfully completed.

2.1.3 Test Results

The Alarm Analyzer demonstration was performed using the same substation information server that would be used on-line. This equipment interacted with signals and components identical to those installed at Dalton Substation, the test case substation for this part of the

Project. Working off-line with a controlled set-up allowed many different scenarios to be simulated and triggered at will to generate the required data and complete the development effort within a reasonable schedule and budget.

Feasibility of the Alarm Analyzer concept was demonstrated successfully off-line for the Dalton 66/12 kV Substation using two actual scenarios and the same type of communication and device signals available at the substation.

A bus tie circuit breaker trip and a feeder circuit breaker trip were simulated. The Alarm Analyzer was able to accurately detect, locate, and identify the disturbance in both scenarios. With the Alarm Analyzer in use, the alarms generated were filtered and reduced in number from seven to one in Scenarios 1, 2, and 3. The simplified and prioritized information was displayed on a screen showing the same one-line diagram of the substation used by the control room operators overseeing Dalton Substation. The screen was animated with blinking color-coded messages (differentiating between minor- and major-class alarms) and sound to alert the operator to the failed components. It was observed that through use of the Alarm Analyzer, the time required to produce an accurate diagnostic of an event could be reduced from several hours or days to less than 2 minutes.

The main hardware selected to build the Alarm Analyzer system was the HIA DAS 4000 substation information server (SIS) and a Sun Workstation. The SIS contains the necessary protocols to interface with the relays and other monitoring devices with minimum customization. The SIS also has enough computational capacity in its calculator to process the analyzer's logic program. The programming required is relatively simple and can be learned in a few hours by a person with average programming skills. However, the vast number of possibilities for different scenarios make it necessary to first develop more sophisticated logic that would allow the logical combination of basic building blocks to create the correct variations of scenarios in response to the protection device signals collected.

In view of the clear and positive results achieved and the large potential impact of the Alarm Analyzer, a continuation of this work in the form of a pilot project at a typical regional control center is strongly recommended. The intelligent alarm analyzer's information regarding the type and location of the disturbance would be combined with an outage estimator system to generate an alert and inform the affected customers of the expected outage duration time.

2.2 Voice Recognition Task

2.2.1 Concept Development, Prototype Design, Installations, and Testing

Development was focused primarily on optimizing performance of existing computer hardware by using the speech recognition functionality currently available with ViaVoice 98 Executive software. Recent advances in continuous speech recognition, program navigation, and related new equipment promise significant benefits in reducing the man-hours and reliability of reports generated by substation and transmission field crews. For office documents generated using a PC, voice recognition has proven to be a significant time saver and offers an alternative to physical fatigue of both the eyes and hands. The objective of this effort was to determine user acceptance of current recognition technology and to estimate timesavings using voice recognition for selected work tasks.

The hardware used for this study was a Dell Inspiron 233 MHz. notebook computer with Windows 95 operating system. Substation work utilized a desktop 233 MHz Dell computer with Windows 95 using the SCE network and multimedia hardware. The development effort, described below, is subdivided into three distinct application areas:

- Substation Applications
- Transmission Field Crew Applications
- Office Applications.

2.2.1.1 Substation Applications

Concept Development. Demonstrations were scheduled for two SCE substations, Lighthipe and Moorpark. Following each demonstration, the responses of supervisory personnel and staff were evaluated to determine the utility of using voice recognition to complement existing reporting methods

Prototype Design. A Visual Basic program using the Multiple Document Interface (MDI) feature of Visual Basic was developed. This program, called Multi-Notes, allows multiple document windows for on-line real-time voice reporting and may be operated in conjunction with ViaVoice 98. The Save command of Multi-Notes allows all files to be concurrently saved to disk with a single command. The intent of this program was to replace the pencil and paper scratch pad notes with voice-entered notes and to transfer selected notes, through the copy and paste functions, into TaskMaster 4.0. For the majority of work at substations, it was found that direct voice entry into TaskMaster 4.0 was preferable to using Multi-Notes. Demonstrations involving Multi-Notes were deemed not to provide significant timesavings, except during peak workload intervals. Therefore, attention was focused on direct voice dictation into TaskMaster 4.0, as it was believed this would provide more immediate user benefits.

Installation. ViaVoice 98 Executive, version 5.3.1.30, was installed at Lighthipe along with the Voice Mouse software. TaskMaster 4.0 was installed by SCE personnel and connected to the Lighthipe network. A customized 500-word dictation vocabulary was installed that included locations, cities, names of SCE personnel and abbreviations. Customized dictation and navigation macros were created and installed.

Testing. The Voice Connexion staff performed the testing.

2.2.1.2 Transmission Field Crew Applications

Concept Development. A demonstration of ViaVoice was scheduled at SCE's Compton Metropolitan Transmission office. Initially, the plan was to use a digital recorder to accumulate field data related to the Patrolman's Log (line inspection report required by the California Independent System Operator) and transcribe this information using special Olympus-provided ViaVoice software. Since field crew personnel are provided with a Dell notebook computer for use in their trucks, the initial plan was modified to install ViaVoice directly on the notebook and avoid special transcription hardware and software. Following the demonstration, the field crew supervisor and staff members realized ViaVoice could potentially enhance the existing Patrolmen's Log data entry.

Prototype Design. An SCE Dell notebook computer was configured with an Olympus Personal Computer Memory Card International Association (PCMCIA) card, D-1000 digital recorder and Olympus ViaVoice software was installed prior to the Compton demonstration. At the time of installation, the Olympus dictation software used ViaVoice Gold rather than ViaVoice 98 Executive.

Installation. ViaVoice 98 Executive, Version 5.3.1.30, was installed on a field crew's Dell notebook computer. A field crew staff member was trained on ViaVoice and a customized vocabulary was also created and installed. The vocabulary contained names of eight individual patrolmen and 398 66 kilovolt (kV) line names.

Testing. A patrolman was trained in the customized vocabulary and became familiar with the use of the ViaVoice software. The patrolman experimented with voice dictation while working on the Patrolman's Log.

2.2.1.3 Office Applications

Concept Development. A demonstration of ViaVoice was scheduled at SCE's Rosemead facility for the Manager of Environmental Research, who has limited hand mobility due to a spinal injury. This managerial position requires extensive document creation using Microsoft Office. Following the initial demonstration, the manager expressed interest in having the voice dictation system installed on his computer and applying its functionality to his work tasks.

Prototype Design. The standard ViaVoice system operates with a headset directly wired to the PC multimedia sound card. The manager noted that the wiring restricted his office mobility because it became caught on the arm of the wheelchair. To eliminate the problem, wireless low-cost office microphones were reviewed and selected. Wireless RF headset microphones from Shure Brothers, LightSpeed, Telex and EmKay were review for the office application area. The EmKay was selected because it combines a lightweight headset in a single unit with a transceiver, provides excellent acoustic background rejection, and is easily maintained. The unit is provided with a secondary battery pack mounted to a base unit that readily detaches for insertion into the headset.

Installation. ViaVoice 98 Executive, Version 5.3.1.30, with Voice Mouse software was installed onto the Dell desktop computer. The EmKay wireless microphone, #RF-3296, was installed, tested, and adjusted to operate with computer and associated voice recognition software. The Voice Connexion staff provided voice enrollment and training for ViaVoice.

Testing. Practice and testing was performed using SpeakPad and MS Word 97. In the case of this user, recognition with the wireless was observed to be excellent.

2.2.2 Test Procedures

2.2.2.1 Substations

We created a script modeled on actual TaskMaster reports. The script contained two Clearance Reports, two Main Log Entry Reports, one 220 kV Interrupt Report, one System Status and one A.M. Report. This script was used to measure and compare keyboard data entry with that of voice.

2.2.2.2 Transmission Field Crews

To compare keyboard versus voice, three fields of the Patrol Log were selected for testing. The three log fields selected for comparison testing were Location (site of investigation), Description, and Comments. The sentences used for comparison are listed below:

- **Location.** Just South of Los Alamitos Steam.
- **Description.** A hawk got into the bottom phase and flashed over the post-type insulator.
- **Comments.** The repair to the insulator will have to be completed on a different day.

Additionally, live dictation in the truck was performed in the field using the Patrolman's Log.

2.2.2.3 Office

Dictation was performed using the desktop computer and the wireless microphone.

2.2.3 Test Results

2.2.3.1 Substation

Testing was performed by Voice Connexion at Lighthipe using the Dell desktop computer operating directly into TaskMaster 4.0. The results of the multiple reports with dictation of 225 words into seven reports yielded the following comparison:

- Voice = 7.5 minutes Keyboard/Typing = 15 minutes
- Voice Rate = 30 words/minute Typing Rate = 15 words/minute.

The above results are not representative of normal dictation rates, typically 120 to 180 words per minute. Nevertheless, voice rate is twice that of a typical male, non-secretarial, touch typist. The low dictation rate is due to several factors. For each of the seven reports, only a few words are dictated into many of the various fields, extensive movement between fields is required, considerable delay is due to accessing each of the seven reports (even with navigation macros). The 233 MHz. Dell machine, although acceptable for use with ViaVoice, could benefit significantly with a commercially available 450 or 500 MHz machine. Some degradation of response time was observed to be associated with Novell network delays.

2.2.3.2 Transmission Field Crew

Using the above-cited test procedure of the transmission field crew, the above test results were obtained.

- Keyboard Entry. = 129 seconds (approximately 2 minutes)
- Voice Entry. = .17 seconds plus about 5 seconds for editing.

In the field, after adjusting the microphone gain of the notebook computer for truck noise, voice recognition dictation operated satisfactorily when operated in conjunction with the Patrolman's Log. It was suggested that a microphone with an ON/OFF switch would enhance performance.

2.2.3.3 Office

Voice dictation using the EmKay wireless microphone in a relatively noisy office cubicle was found to be excellent. The dictation performed was rapid, natural, accurate and integrated well with typical office work tasks.

2.2.4 Demonstrations

To evaluate the voice recognition technology, demonstrations were performed at sites where the users themselves would apply these tools. This was important because real-world conditions, such as ambient noise interference on the headset microphones, use of specialized vocabulary by the operators, and computer literacy of the personnel, had to be accounted for in the assessment. In this project, field personnel's feedback was the most important data to be obtained.

This Task was performed at four different sites involving three different applications as follows:

2.2.4.1 Substations:

- **Lighthipe Substation.** The first demonstration was performed at Lighthipe Substation, a Regional Control Center with jurisdiction and control over more than thirty substations. Four operators are present during the day shift. The earlier releases of IBM's Via Voice software had been previously evaluated at Lighthipe. The substation's personnel at that time requested an electronic version of their paper scratch pads. These pads are sheets of paper divided into cells used by the operators to write their notes during extra busy periods and later used to fill out reports. With the electronic pad developed in this project the operator creates as many cells as needed, titles each cell according to her needs, and can dictate directly to each. Later she can quickly edit, cut, and paste the information to the proper report forms.
- Management at Lighthipe Substation requested the development of four frequently used reporting forms to input text directly by voice. Since these reports are used frequently, the benefit of voice input would be available not only during the peak activity moments but also throughout the day. A shell program called TaskMaster manages these reports and many other documents used at the control consoles. The challenge was interfacing the voice recognition with TaskMaster. This was accomplished in spite of several changes due to a major upgrade to TaskMaster. The four reports can be completed via voice in less than half the time needed to complete them using the keyboard and mouse by a touch typist. The accuracy achieved was 97 percent and improved with increased use of the program because of the recognition capabilities of the software. Higher productivity can be obtained when dictating documents with larger amounts of text. The reports are usually one page long and have only a blank or a few lines to fill in at a time. The operators noted that the brief sections of text they use and the lack of experience with dictation made voice input seem awkward, although it was still faster than typing in the information.
- **Moorpark Substation.** The use of the electronic scratch pad (MultiNotes) and the four reports were demonstrated at a second regional control center at Moorpark Substation.

This permitted a more thorough test of the software's compatibility, which caused the weaknesses to surface. At Moorpark a connection to the server which hosts TaskMaster could not be established and the backup copy residing on the demo PC had to be used. This created some erratic responses when inputting the same type of information, which had no problems at Lighthipe. Navigation via voice also had certain glitches not observed previously. These problems are attributed to different TaskMaster versions and to the lack of robustness in Via Voice to handle these changes.

2.2.4.2 Field Transmission Crew

- A different application involved a transmission line patrolman who inspects the overhead lines and structures as he drives by the installations. This is an inspection mandated by the California Independent System Operator and a one-page form with the patrolman's comments is required. The inspectors have to stop their vehicle to write or wait until they are back at their desk. In either case the procedure is not efficient and is prone to error, as it depends on the inspector's memory. With voice input, the time required to enter all the information on the form was approximately three times faster than by hand and the accuracy was practically 100 percent after re-calibrating the headset's microphone to account for the vehicle's and road noise. This application showed that voice input frees the person's hands and eyes and enhances multitasking, in this case contributing to improved system reliability and safety. Initially, a digital recorder was to be used to dictate in the field and then the information was to be downloaded to a PC in the office. But the patrolman carried a laptop and dictation was done directly into the laptop. The compatibility errors observed at Moorpark were not present here due to an improved interface between the voice and TaskMaster software loaded on the PC. The patrolman and his supervisor commented that their report comments are too short to consider changing to voice input only.

2.2.4.3 Office

- The last demonstration was an office application for a manager with limited hand and arm mobility who was confined to a wheelchair. This person, who had experience with other voice recognition systems, reported that this system was easy to use as well as accurate. He experienced a problem with the headset's cord, which would tangle on the wheelchair. The standard headset was replaced with a wireless headset, with excellent results. Another minor problem was a conflict with an existing application, which had to be closed when using Via Voice. The user commented that his productivity improved when using voice input on long documents but was not worth setting up for brief text like e-mail messages. He also observed that a cubicle environment is not conducive to dictation because of the distraction from and to neighbors. He also felt self-conscious dictating in an environment with no privacy. A voice-activated mouse was tested with good results in terms of accuracy, which could greatly benefit those people prone to carpal tunnel syndrome or who are physically impaired.

Voice data input has been demonstrated to have a strong potential to improve productivity and accuracy. In the cases of the control room operators and the patrolman this would contribute to improved reliability at substations and lines. The technology is

ready for system-wide use, but the applications have to be judiciously selected to obtain its full benefits, and it has to be implemented with care to avoid interface problems.

The above-outlined demonstrations enabled comparisons between existing methods and the proposed technologies. These comparisons made evident the impact on reliability of applying these technologies because accuracy and speed of response were considered. Although it was too early in the development process to establish exact costs and benefit values, the governing parameters could be identified. Preliminary indications of the relative merits and competitiveness of the technologies could be deduced and used to determine further efforts.

3.0 Conclusions and Recommendations

3.1 Project Objectives

The project objectives were to:

- Complete the initial stage of development of an intelligent alarm analysis and diagnostics system to automatically classify and filter the thousands of pieces of information and alarms generated during an abnormal event on the grid, such as a regional blackout caused by a fault. The scope was limited to investigating the feasibility of the Alarm Analyzer tool.
- Implement voice recognition technology and evaluate its benefits in the entry of data and commands into a computer or other device in control rooms and other applications.

3.2 Project Outcomes

The objectives were met by developing the Alarm Analyzer tool, implementing voice recognition technology, and conducting successful demonstrations of each.

Project findings were:

- Use of the Alarm Analyzer tool reduced the time required to produce an accurate diagnostic of an event from several hours or days to less than 2 minutes. These results are based on simulations of actual events occurring at the Dalton Substation.
- The voice recognition tools evaluated in this project resulted in a productivity increase of at least 200 percent in entering information into a computer file, with an accuracy rate greater than 97 percent. These results are based on a comparison between keyboard entry methods and voice input.

3.3 Actual Findings

In all areas reviewed in this study, substations, transmission field crew, and office personnel, manpower and timesavings were observed. Cost savings are directly related to the amount of time spent performing manual keyboard text entry or speech-to-text entry. Therefore, maximum benefits accrue where large amounts of text are entered.

The text entry work tasks for the application areas reviewed vary widely. For this reason, economic saving using voice versus manual input is difficult to estimate unless it is directly related to specific SCE application areas. Nevertheless, this section of this report details what appears to be a reasonable typical savings with the use of voice recognition.

Complementing existing SCE computer systems with ViaVoice 98 Executive software requires a minimal cost per user (less than \$150 in single unit quantities). Additional peripherals related to application needs, such as RF voice I/O, telephone and computer access, or custom array noise canceling microphone, increase per user cost.

Software installation and voice enrollment by individual users requires approximately 2 man-hours. Use of voice with application software and recognition corrections and customization are estimated to require an additional 4 to 6 hours. Support customization and individual training service of 4 hours typically incur an additional cost of \$500.

Installation, training, and system optimization are estimated to require 8 hours per user with an estimated hourly rate of \$20. This yields:

Software Cost	=	\$150
Training Services	=	\$500
SCE Manpower Cost	=	\$160 per user
Total	=	\$810

To estimate the cost savings, a man-year is assumed to be 2,000 hours. If, in general, 10 percent of these hours are used in reporting, this yields 200 hours per year for documentation. At the above rate of \$20 per hour, this cost would be \$4,000. Since voice should save at least 40 percent of this reporting time, only 120 work hours would be needed when using voice. Using these assumptions, this yields a saving of 80 hours per year times \$20 = \$1,600 per person per year. Note that the payback period for the initial investment is approximately 6 months to recover the \$810 expenditure. This is considered a conservative estimate, since e-mail and other correspondence will also benefit from voice dictation, in addition to report documentation.

Entering data into Taskmaster 4.0 and the Patrolmen's Log requires the operator to view the computer screen to input information into each specific field and move between fields. Speech dictation into Microsoft Word or the ViaVoice Speak Pad does not require constant viewing of the screen. For this reason, database field dictation is more taxing and slower than normal continuous dictation speaking rates. An interactive field prompting, with recognition verification of the spoken field would greatly enhance the user friendliness of database real-time information capture systems. Currently, general-purpose large vocabulary continuous speech systems do not afford this degree of man-machine interaction. The need for this technology exists in many areas besides the needs of SCE, i.e., warehousing, distribution, inspection, inventory, paperless picking. Recent handheld microprocessor developments and current recognition technology properly combined now allow this type of application functionality to be achieved.

3.4 Conclusions

- Voice data input has strong potential to improve productivity and accuracy. For control room operators and the patrolman, this could contribute to improved reliability at substations and lines.
- While the technology is ready for system-wide use, applications have to be judiciously selected, and implemented with care to avoid interface problems.

3.5 Recommendations

Suggested improvements to be implemented in the various applications are provided below.

3.5.1 Substations

The reporting with TaskMaster 4.0 and ViaVoice would be substantially more efficient if the Dell machines were upgraded from 233 MHz to 450 to 500 MHz.

When Microsoft Word is upgraded to Word 97 (version 8), ViaVoice features can be more completely used and TaskMaster 4.0 can be more closely integrated with voice.

Inspection of substation equipment and inventory control can be accomplished using the stand-alone MicroIntroVoice II or alternately with the new DS-150 digital recorder and with ViaVoice 98 Executive.

3.5.2 Transmission Field Crews

A more hands-free and remote method for voice input to the notebook computer is better suited to this application than direct headset wiring to the notebook.

Wireless operation at a distance of 20 to 30 feet is now available with the EmKay headset (RF-3296). This unit provides excellent recognition, even in a fairly noisy environment, and does not require the user to be tethered to the notebook computer. The unit is provided with a headset mute switch. This allows the operator to terminate the headset audio pickup when recognition is not desired or for the voice system to ignore other radio conversations.

While the inspector is in the truck and entering data into the Patrolman's Log, two additional new microphones should be considered: the Andrea AutoArray hands-free automotive microphone and the ANC-300 hand-held computer microphone.

3.5.3 Office

The greatest gains in productivity for using voice recognition are where a large portion of a person's time is spent generating a text document. Entry into structured database reports is slow relative to standard word processing speeds. Dictation into a word processor actually can be done at a rate of 120 to 180 wpm versus 60-80 wpm for a skilled typist.

Fatigue and hand or eye damage can occur due to repetitive muscle use. Voice dictation does not require the eyes to view the computer screen, except to edit generated text, thereby reducing eyestrain. For prevention of carpal tunnel symptoms or for people with carpal tunnel, voice is highly recommended as an alternate or supplemental technology for text generation.

Where noisy office cubicles interfere with voice recognition, the EmKay wireless or a similar product should be used instead of the standard headset microphone.

Phillips' new SpeechMike device provides an all-in-one handheld microphone, with loudspeaker, mouse trackball and programmable buttons designed to be used with voice recognition software products such as ViaVoice and Voice Connexions SpeechRecorder. This unit is ideal for executives and legal staff.

These factors, as well as aid to the disabled, establish a clear need for further service efforts directed toward office work at a utility's facilities.

3.6 Summary

In summation, Alarm Analyzer and voice recognition technologies have proven to promote substation reliability by filtering alarms for the operators, thus avoiding information overload. In view of the successful demonstration of the Alarm Analyzer, a continuation of this work in the form of a pilot project at a typical regional control center is highly recommended. Voice recognition technologies also have the potential to improve productivity and accuracy by freeing hands and eyes to enable multi-tasking. In the case of the control room operators, this would also contribute to substation reliability. Although the technology is ready for system-wide use, applications should be judiciously selected for maximum benefit and implemented with care to avoid interface problems.

Appendix I
Intelligent Alarm Analyzer Project – Preliminary Requirements

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Intelligent Alarm Analyzer Project

PRELIMINARY REQUIREMENTS

SUMMARY

April 20, 1999

**Prepared by
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Introduction

Project Description

The purpose of **Phase One** of the project is to design and develop a prototype alarm analyzer system for a pilot project that will demonstrate the concept. This system, the Intelligent Alarm Analyzer (IAA), will ultimately process various alarms and other grid information to determine what was faulted, which circuit faulted, and filter and prioritize alarms. In a subsequent **Phase Two**, the IAA will be capable of analyzing the conditions for possible automated action, and alerting substation operators or field crews.

The proposed system is expected to handle complex fault/malfunction scenarios. For example, false tripping may occur due to malfunctioning. The false tripping can lead to cascading events that are difficult to identify at present.

This system could provide an opportunity for SCE to be proactive about analyzing and responding to certain alarm conditions. It is expected to prioritize the relevant alarms and identify the faulted component(s) and breaker malfunction(s). It will provide timely identification of the faulted components or malfunctioning devices, especially for complex scenarios.

Objective

- ♦ The objective of **this pilot project**, Phase One, is to develop, design, implement and demonstrate feasibility a prototype alarm analyzer at a substation (Dalton).
-

Scope

The Phase One scope is to design and develop a pilot system for demonstration purposes. The project will produce both hardware and software for demonstration at a selected substation.

The scope of this first phase effort is not to implement this product into a production like mode at this time. However, all efforts should be directed with the goal in mind that a production system will be implemented at some time in the future at a Regional Control Center.

The Phase Two scope of the project is to further enhance capturing and categorizing alarm and other monitoring information, along with providing additional capability for analyzing and predicting resulting actions based on that information.

Assumptions

The known assumptions at this time are listed in this section.

- ◆ The Hathaway DAS 4000 SIS will be used to gather different types of data from various online monitoring (OLM) devices and pass that data to SCADA and a central database. (SCADA information via SAS)
- ◆ Hathaway has the knowledge and resources available to develop a prototype of the software described in this request for proposal.
- ◆ Hathaway can meet the proposed project schedule.
 - ◆ SCE Protection and Operations personnel will be available to provide the system data to the supplier and to train on the use of the new hardware and software being procured.

Initial Requirements

Listed below are the high level categories of requirements. Some of these requirements may correspond to Phase II.

Functional Requirements:

- ◆ Filter or screen out irrelevant alarms that were triggered unnecessarily. Display only those which are relevant to the event.
- ◆ Prioritize each alarm according to predefined criteria.
- ◆ The software's data must be SCADA based or able to interface to it.
- ◆ Design the system to be used in the substation selected by SCE, but flexible enough to be easily modified for use at other substations.
- ◆ Detect and determine the location of faults.
- ◆ Perform fault diagnostics to determine and recommend action for all relevant (or a predefined list of) alarms to the control room operator within 30 seconds of the event's initiation.
- ◆ If a fault can not be specifically identified, develop a prioritized list of likely faulted components(s) and malfunctioning device(s).
- ◆ Capture all data available or provided by the online monitoring devices.

**Initial
Requirements
*continued***

Information Requirements:

- ◆ Include event data on faults, circuit breakers and relays.
 - ◆ Include all relevant existing SCADA alarm information available.
 - ◆ Filter or screen out irrelevant alarms that were triggered unnecessarily. Display only those which are relevant to the event.
 - ◆ Filter out unnecessary alarm information.
 - ◆ Prioritize each alarm according to predetermined scenarios by SCE Operations and Protection Engineering.
 - ◆ Perform fault diagnostics.
 - ◆ Use DFR data if available.
 - ◆ Use SAS data if available.
 - ◆ Capture online network connectivity information.
 - ◆ Settings of phase comparison, distance, and overcurrent relays.
 - ◆ Design the system to be used in the substation selected by SCE.
 - ◆ Capture all data available from the latest online monitoring devices.
 - ◆ Write the data into an Oracle database designed jointly with selected SCE personnel.
 - ◆ Training materials and hands-on training for the DAS 4000 must accompany the delivered system.
 - ◆ Training materials and hands-on training for the Intelligent Alarm Analyzer system must accompany the delivered system.
 - ◆ Documentation on system components and operation must accompany the system.
 - ◆ All software must be documented and source code available for SCE to maintain and be in a language that allows for future enhancements.
-

**Initial
Requirements
*continued***

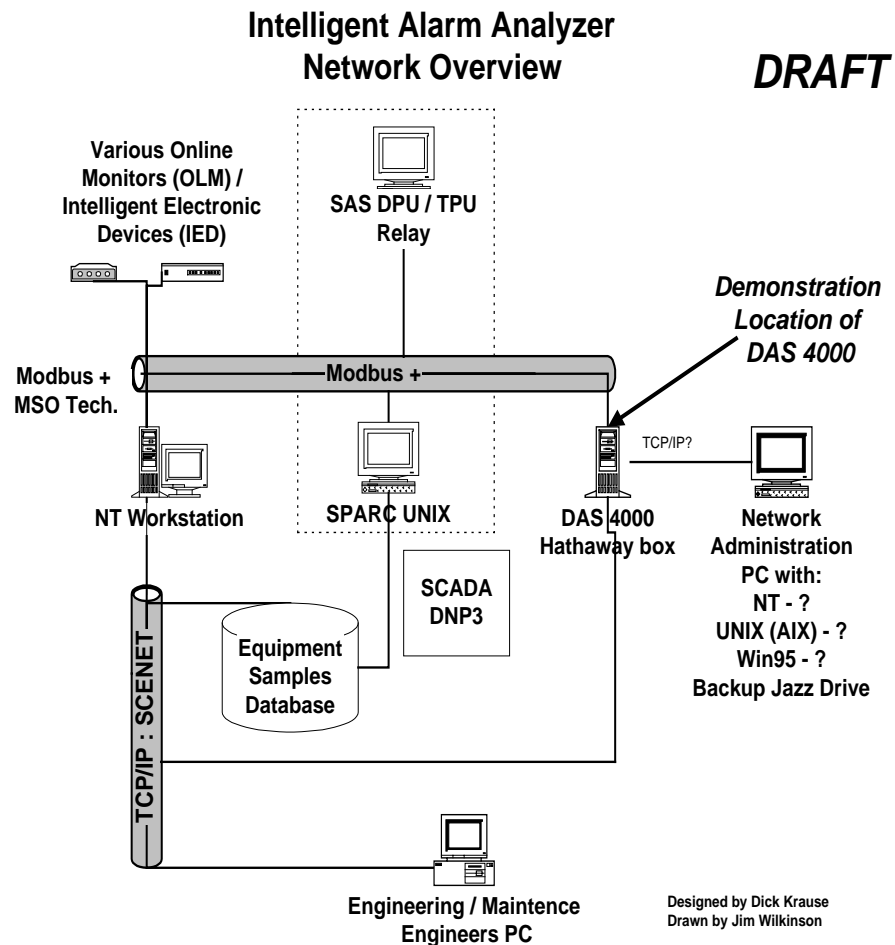
Performance Requirements:

- ◆ Provide data filtering, alarm prioritization, fault diagnostics, and recommendations to the control room operator within 30 seconds of the event's initiation.
- ◆ The system must reside on and utilize an open architecture. (Unix)
- ◆ Comply with the existing SCE substation environment.
- ◆ Comply with the existing SCE hardware and software computing environments.
- ◆ Connect system and run it on existing SCE LAN.
- ◆ Ensure that the performance of the existing computing environment will not be impacted.

**Initial
Requirements
continued**

Special Requirements:

- ◆ The end-user interface of the system must be easy to learn and understand.
- ◆ The operators will not notice any performance problems within the existing computing environment, with the additional new IAA software.



Early Project Schedule

This project has a fixed final delivery date of August 20, 1999 due to project funding. Therefore the project schedule will be planned backwards to accommodate this situation. The following high-level deliverables are planned to meet the project final delivery date.

Action	Start Date	End Date
Initial system design by SCE	1/24/99	1/24/99
Initial project proposal from Hathaway	3/16/99	3/16/99
SCE to prepare detailed request for proposal	3/26/99	4/6/99
Detailed project proposal from Hathaway	4/6/99	4/12/99
Sign agreement to proceed	4/12/99	4/26/99
Hathaway to deliver Hardware	4/26/99	5/14/99
Hathaway to deliver Software	5/14/99	6/25/99
Hathaway to demo and train SCE	7/26/99	8/6/99
Prepare report for final deliverable to California Energy Commission	7/19/99	8/20/99

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